

## PATENT SPECIFICATION

DRAWINGS ATTACHED

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## COMPLETE SPECIFICATION

## Disposable Diaper

We, CANADIAN INTERNATIONAL PAPER Company, a Corporation of the Province of Quebec, Canada, of Sun Life Building, Dominion Square, Montreal, Province of Quebec, Canada, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a method for the production of an assembly of material to form absorbent diapers and to the assembly produced thereby, and was divided from the co-pending Application No. 36805/66 (Serial No. 1164491).

Absorbent products in the form of diapers are most convenient when in a form which renders them readily disposable. Disposable diapers which found their initial appeal in the convenience which they afforded for traveling, now enjoy widespread use as a permanent substitute for cloth diapers, which require storing and laundering. Besides the obvious advantages inherent in disposability, diapers formed, for example, of wood pulp and tissue can be produced in a variety of different ways so as to provide a number of advantageous features which cloth diapers are incapable of providing.

In fabricating an absorbent diaper, a prime consideration is the ability of the diaper to receive, distribute and retain body fluids. More specifically, it is important that the diaper, in the form which it assumes when worn, be capable of rapidly dispersing fluids to all parts of the diaper capable of readily absorbing same before the fluids saturate and "strike through," i.e., penetrate those portions of the diaper initially contacted. It is also important that the diaper, in such form, be capable of retaining solids and semi-solid body excretions despite the activity of the child. These features

must be coupled with the ability of each section of the diaper to which fluid is conveyed to retain such fluid. However, in addition to possessing these properties, the diaper must also be capable of conforming comfortably to the body of the child and must be able to retain its strength when wet.

Also, a disposable diaper, even though providing comparable or improved functional properties, must be capable of being produced on a large scale at a cost which will enable it to compete favorably with cloth diapers. That is, the diaper must be produced in a sufficiently economical manner that it may be used once and thrown away at a cost competitive with the per use cost of cloth diapers which are laundered at some expense for repeated use.

According to the invention there is provided an assembly of material for forming disposable diapers comprising a pad of loose fibers of cellulosic material formed as a single layer, and an envelope enclosing said pad, said enclosed pad having side edge portions folded inwardly and then back upon themselves so that on each side there is formed a leg-engaging pleat, said pleat having an inner and outer fold, the folds of the pleats being permanently compressed by calendering and thereby being held down, and the portion of the pad intermediate said pleats being relatively uncompressed.

According to the invention there is further provided a method of assembling material to form disposable diapers comprising the steps of continuously moving a permeable carrier web having a predetermined width along a given path, continuously laying on said carrier a pad of loose fibers of cellulosic material as a single integral layer with the pad extending longitudinally of the carrier, forming an envelope around the pad to enclose the pad by

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folding the carrier web, folding each side edge portion of the enclosed pad inwardly and then back upon itself to form a leg-engaging pleat, having an inner and outer fold, along each side of the unpleated central portion of the pad, and subjecting the enclosed folded pad to calendering pressure normal to the plane thereof so as to impart a permanent compression to hold down the outer fold tightly against the inner fold without imparting any significant permanent compression to the portion of said pad intermediate said pleats.

Specific embodiments of the invention will now be described with reference to the accompanying drawings in which:

Figure 1 is a perspective view of an absorbent product in the form of a disposable diaper, showing various of the features of the invention;

Figure 2 is an enlarged sectional view taken along line 2—2 of Figure 1;

Figure 3 is an enlarged fragmentary sectional view, taken along line 3—3 of Figure 1;

Figure 4 is an enlarged fragmentary sectional view taken along line 4—4 of Figure 1;

Figure 5 is an enlarged sectional view taken along line 5—5 of Figure 1;

Figure 6 is an enlarged perspective view showing the diaper of Figure 1 as it might appear on the body of a child;

Figure 7 is an enlarged diagrammatic view, partially in section, illustrating the relative positions of a portion of the diaper of Figure 1 and portions of the body of a child when the diaper of Figure 1 is worn by a child;

Figure 8 is a sectional view similar to that of Figure 2 but showing an alternative embodiment of the diaper of Figure 1; and

Figure 9 is a diagrammatic view illustrating a method by which the diaper of Figure 1 may be formed.

Very generally, the illustrated diaper 11 includes a first or inner web 13 enclosing an absorbent pad 15. The edges of the web 13 are shown folded over the pad 15 to form two layers on top of the pad. The enclosed pad is preferably provided with longitudinally extending channels of embossment 17 and is in turn enclosed by a similar second or outer web 19 which is reinforced by means of tissue strips 21 positioned so as to be located at each end of the diaper. The webs 13 and 19, the latter of which is reinforced by the strips 21 and folded in the same manner, form an envelope 23 for the pad. End edge portions 25 of the diaper are embossed or stamped to unite the envelope and pad and are provided with notches or slits 27 to facilitate separation of the diaper into longitudinally extending strips so as to render it more readily disposable in toilets and the like. The side edge portions of the diaper are folded to form pleats 29 held in place by spot embossing 31.

The construction of a preferred embodiment of the diaper 11 can more easily be understood

when described in conjunction with the method by which it is formed. In accordance with a preferred method, illustrated diagrammatically in Figure 9, the web 13, in continuous form, is moved in a generally vertical plane and has deposited thereon the pad 15, preferably by air-laying the pad directly onto the web. The web is then folded around the pad to enclose it, and the enclosed pad moved horizontally. Longitudinally extending channels 17 are then embossed into the enclosed pad, as by die and anvil rolls 17a and 17b, respectively.

Meanwhile, the web 19, also continuous in form, is traveled horizontally and has the reinforcing strips 21 deposited upon it by cross laying the strips on the web at predetermined intervals. The extent of the intervals, i.e., the distance between the strips, is determined by the length of the diaper to be formed. The enclosed pad is then laid upon the web 19 and strips 21, and the web 19 is folded around the enclosed pad to provide the envelope 23. The envelope is then embossed transversely in the area of the strips 21, as by die and anvil rolls 21a and 21b, respectively, to provide the embossed end edge portions 25. Subsequently, the diaper is folded to form a portion of each of the pleats 29, spot embossed at 31, as by die and anvil rolls 31a and 31b, respectively, to secure the pleats in place, and folded again to form the complete pleat. Finally, the diaper is compressed by calender rolls 32 and severed by means of an orbiting rotating circular saw 33 which passes centrally of the transverse embossing and the strips 21.

Now considering the individual elements of the formed diaper 11, the web 13 preferably consists of a single ply, 10 pounds basis weight, high wet strength creped tissue paper having about 25% stretch and about three times the strength in a direction extending longitudinally of the diaper as transversely. The stretchability of the web and the creped nature thereof enables it to withstand anticipated stress resulting from handling, from the placing of the diaper upon the child, and from the activity of the child. The high wet strength is attained by incorporating sufficient melamine resin or another suitable wet strength agent in the furnish. Preferably, the web has a strength when wet equal to about 25% of its strength when dry, as determined by the testing methods set forth in Standard D. 10 of the Physical and Chemical Standards Committee, Technical section, Canadian Pulp & Paper Association. This wet strength, particularly in a direction extending longitudinally of the diaper, renders it particularly capable of supporting the weight of the diaper and the weight of a substantial quantity of bodily waste contained within the diaper, in spite of the normal continuing activity of the child. However, the possession of significantly less strength in a direction extending transversely of the diaper enables the web to be easily sepa-

rated into longitudinally extending strips for disposal, as set forth more fully hereinafter.

Preferably, the web is slightly less than three times the width of the pad 15 so that the web may be folded around the pad while leaving the side edges of the overlapping portions of the web spaced inwardly from the side edges of the enclosed pad.

The pad 15 is deposited on the web 13, preferably directly by an air-laying process and in the preferred form, seen best in Figure 2, is defined by a single layer of sulphite sulphate or other purified wood pulp which has been disintegrated into loose fibers and reformed into an elongated batt. The pad is integral, that is, there are no internal boundaries within the pad, as in multi-layered pads, along which various portions thereof might be displaced relative to each other or which might become separated or spaced from each other in a manner which would hinder a continuous desirable distribution of body fluids throughout the diaper. The absence of internal boundaries also insures a uniform flow in all directions within the pad. In addition, a single layer pad possesses fiber to fiber contact throughout, thus providing better wicking action.

To ensure an efficient reception and retention of body fluids, the pad is provided with a non-uniform cross-sectional configuration having a longitudinally extending portion of greater thickness than an adjacent portion extending in the same direction. In the preferred embodiment of Figures 1 through 4, a longitudinally extending central portion 35 of the pad is provided which is of greater thickness than flanking side portions 37. For example, the central portion 35 may be approximately one-quarter inch in thickness while the outer portions may be approximately one-eighth inch in thickness. Thus, where the thickness is properly chosen, the central portion 35 has an increased fluid retaining capacity as compared to the central portion of a pad of uniform cross-sectional configuration and, generally speaking, fluid will flow to the side edges of the diaper only when this capacity is exceeded. The central portion 35 in the illustrated embodiment has a width approximating the width of a pleated or folded diaper, the flanking side portions 37 thereby defining the upper two layers of the pleats 29.

The pad 15 is preferably approximately one-third the width of the web 13 and is preferably laid centrally thereof so that, after it has been formed, the edge portions of the web may be folded around it so as to enclose it. In the preferred method, this is accomplished by means of a folding shoe (not shown) which first folds the left-hand side portion over the pad, as viewed in the direction of travel, and then folds the right-hand portion over the left.

It will be appreciated that fluids are received by the diaper in relatively large quantities over a short period of time and that, if

this flood of fluid were allowed to remain in only a small portion of the diaper, it would soon "strike through". In order to effect more rapid distribution of this fluid, the enclosed pad is preferably longitudinally embossed by a series of the generally parallel channels 17 after the web 13 has been folded, as above. The longitudinal embossing provides irrigation ditches or channels along which body fluids flow, thereby effecting a more uniform distribution of the fluids throughout the diaper and rendering the entire absorptive capacity of the pad more effective. Preferably, the channels do not bond or glassine the fibers and web but instead merely compact the fibers. The channels are applied intermittently, i.e., they do not extend continuously throughout the length of the uncut enclosed pad but occur at intervals therealong. In the formed diaper, therefore, the channels terminate short of the transversely embossed and edge portions 25 to discourage liquid from reaching the ends of the diaper and causing disintegration of the girth portions which hold the diaper together.

In the preferred embodiment, in which the central portion of the pad 19 is of greater thickness than adjacent flanking portions, the channels 17 of embossing are desirably confined to the central portion of the diaper. Four such channels or grooves are provided, each having a length approximately one-half the length of the diaper and each being approximately one-eighth inch wide. The channels, ideally and as shown in the drawings, have a curved base having a onesixteenth inch radius, have a depth of approximately one-eighth inch, and are spaced from each other approximately seven-eighths of an inch. They are formed by the cooperative action of the rolls 17a and 17b. The roll 17a is provided with two circumferentially spaced sets of raised ribs, while the roll 17b is in the form of a hardened anvil roll. The rolls are urged together under pressure and provide the pad with a permanent set at the areas of embossing which reduces the thickness at such areas to between one-third and one-tenth of the original thickness. It should be apparent from Figure 2 that the channels 17 actually increase the absorptive surface area of the pad by creating lateral surfaces through which the fluid can flow into the pad for wicking away.

The embossing of the pad 15 after it is enclosed by the web 13 rather than before is preferred since it eliminates the problem of the embossing roll picking up the loose fluff. Also, the embossing of the web 13 serves to maintain the integrity of the channels and enmesh the web to the pad. Embossing of the enclosed pad before the web 19 is applied is also advantageous in that the subsequent addition of the web 19 provides limited passageways under the outer web through which fluid can flow.

Concurrently with the laying of the pad 15

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on the web 13, the reinforcing strips 21 are deposited upon the web 19. The web 19 is similar to the web 13 and preferably consists of a single ply, 10 pound basis weight high wet strength creped tissue having about 25% stretch and about three times the strength in a direction extending longitudinally of the diaper as transversely. The wet strength of the web 19 is substantially that of the web 13, as previously set forth. Also, the web is approximately the width of the web 13 so as to be slightly less than three times the width of the enclosed pad 15, leaving side edge portions for folding around the pad, as hereinafter described.

The reinforcing strips 21 are deposited on the moving web 19 in spaced relation to one another preferably with their centers spaced from one another a distance approximately equal to the length of the finished diaper so that, when the diaper is placed on the child, the strips encircle the child's waist to form a band or belt. The strips make it possible for the diaper to fit snugly around the waist of the child without causing discomfort, and preferably possess sufficient elasticity to enable them to conform to the stomach and back of the child much in the form of a wide elastic band of a cloth garment. Also, the strips reinforce the ends of the diaper, permitting considerable activity without a tearing or parting at the waist, thus relieving the end edges of the pad and envelope of stress. The strips also add strength to the diaper in the area where safety pins or other fastening means are received. However, although the bands generally resist tearing in normal use, the width is not so great as to preclude tearing of the strips when it is desired to separate the diaper into segments for disposal.

It has been found satisfactory to form each strip of four plies of high wet strength creped tissue of 12 pound basis weight having a 40% stretch and having at least three times the strength in one direction as in the other. The strips might measure approximately 8 inches x 12-1/2 inches for a diaper 16 inches in length, and are disposed with their line of strength and longest dimension extending transversely of the web. When the enclosed pad is severed to provide the individual diapers, the line of severance preferably occurs at approximately the center of the strips 21, separating the strips into two essentially equal parts, of approximately 4 inch width, each of which parts thus becomes located at one end of each of a pair of successively formed diapers.

The pad 15 enclosed by the web 13 is joined with the web 19 on which the reinforcing strips 21 are arranged. In the illustrated embodiment of the method, as shown in Figure 9 the web 19 is moved horizontally and the enclosed pad is brought into engagement therewith from above. The strips 21 are preferably held in

place by vacuum from the time at which they are deposited on the web until the web is joined with the enclosed pad, after which they are locked in place between the two webs. After the enclosed pad has been laid on the web 19, the side edge portions of the web 19 are folded around the pad in a manner similar to the folding of the side edge portions of the web 13 to complete the envelope 23. Preferably, and because the webs 13 and 19 are less than three times the width of the pad, the longitudinally extending edge 38 of the uppermost wrap of the web lies in the crease of one of the pleats 29, soon to be described. The location of the edge 38 within the pleat 29, which is the principal reason for the above referred to dimensioning of the webs relative to the pad, prevents this edge from cutting or irritating the skin of the child, and also prevents this edge from remaining unattached.

The enveloped pad is then embossed transversely of its length approximately centrally of each of the areas where the bands 21 are located, thereby securing the bands to the web and also securing the pad 15 to the envelope 23. The severance of the enclosed pad by the circular saw 33 is preferably centrally through the embossed area, thereby forming an embossed end edge portion 25 for each of successive diapers. The transversely embossed area is preferably of a much lesser width than the bands 21, e.g. a width of embossing of one inch as compared with a band width of eight inches in the uncut web, or an embossing of one-half inch as compared with a band width of four inches in the completed diaper, so that a substantial unembossed portion of each band exist on each side of the embossing. In addition to maintaining the envelope 13 in its closed condition, the embossing provides a convenient stiff durable area at the ends of the diaper, reinforced by the bands 21, for receiving safety pins or similar fasteners, as previously mentioned.

Simultaneously, with the provision of the transverse embossing, the embossed area may be provided with a pair of transversely spaced, longitudinally arranged slits 39 (Fig. 9) which, when the enclosed pad is separated into individual diapers, form the slits or notches 27 extending inwardly of the end edges of each diaper. These slits facilitate the separation of the diaper longitudinally into three generally equal portions, which can be flushed down a toilet or otherwise disposed of somewhat more easily than can the entire diaper. These slits are also capable of spreading when the diaper is placed on the child and therefore provide a more comfortable fit. Preferably, the slits have a length of approximately one-half inch. It is understood, of course, that the provision of the slits is optional and not an essential feature of the invention nor necessary to an advantageous utilization thereof.

The pleats 29, provided at the side edges

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of the diaper, serve to provide a seal around the legs of the child and prevent body fluids from passing outwardly of the diaper in the vicinity of the legs. In a preferred form of the diaper, each pleat is approximately one and one-half inches in width and is formed by folding the side edge portions of the diaper inwardly, i.e., toward the center of the diaper and then back upon themselves to provide each pleat with two folds 29a and 29b overlying the marginal edge portion 35a of the central portion of the pad. In the illustrated method, the side edge portions are first folded inwardly along a line generally coextensive with the side edges of the thicker central portion 35 of the pad 15 and are spot embossed, as at 31, with sufficient pressure to glassine the cellulose, thereby holding the first fold 29a in place. The second fold 29b, which is innermost or nearest the skin when the diaper is worn, is made subsequently, covering the embossed spot 31 to prevent it from causing any possible discomfort. The pleats insure a close fit around the legs of the child; the spot embossing locks the fold 29 to the edge portion 35a while the unsecured fold 29b of the pleat can unfold or expand into contact with the leg.

After the enveloped embossed pad is pleated and before it is separated into individual diapers by the saw 33, it is calendered, i.e., the enveloped embossed pleated pad, which constitutes in effect a plurality of unseparated diapers in strip form and will hereinafter be referred to as diapers, is subjected to a high compressive flattening pressure for a brief period of time. In the illustrative embodiment, this is accomplished by the set of calendering rolls 32 which are urged toward each other under pressure while the diapers pass between them.

Although the calender rolls subject the diapers to extensive compressive forces over their entire surface, the greatest degree of compression, both temporary and permanent, is sustained by the pleats 29 while only slight temporary and little or no permanent compression is sustained by the portions of the diapers intermediate the pleats. This is due to the fact that the diapers are much thicker at the pleats and, hence, the areas intermediate the pleats are not subjected to compressive forces until the pleats have been compressed a significant amount. Since the absorptive capacity of the fluff pad 15 is reduced by compression, calendering the diapers after they are pleated prevents the portion of the pad intermediate the pleats from being compressed and, hence, prevents reduction of the absorptive capacity of that portion. This is an important feature of the diaper since it is this unpleated portion which receives the initial flood of body fluid, as previously mentioned and, hence, ideally possesses the greatest absorptive capacity.

It is desirable that the diapers be subjected to a pressure of sufficient magnitude to hold

down the pleats and desirable that this pressure also be sufficient to cause the diapers to remain in a compressed state until they are packaged. However, the pressure should not be great enough to render the diapers stiff and hard or cause the fluff to become plastic and to flow. In a preferred embodiment the pleats received an instantaneous compression of between fifty and sixty percent (50—60%) in the nip. There is a recovery from this initial compression before packaging which provides a net reduction due to calendering of fourteen percent (14%) in the finished diaper at the time of packaging.

The calendering of the pleated pad, as previously mentioned, puts permanent folds in the diapers at the pleats, thus causing the pleats to retain their shape both while the diaper is packaged and while it is being worn. The calendering therefore preserves the appearance of the diaper and insures the full effectiveness of the pleats.

In addition, the calendered diapers are flatter, more readily stackable and, because of their compressed state, provide a more compact package requiring less packaging material and less storage space.

The enveloped embossed pad is separated into individual diapers by the rotating orbiting circular saw 33 which passes through the pad midway of the transversely extending embossed areas and reinforcing strips 21. Thus, each diaper end created by the severance is embossed and includes a portion of a reinforcing strip. The use of a rotating circular saw for severance is preferred over other forms of cutting, particularly a chopping form of cut, since it provides a relatively loose fluffy edge which is less irritating to the tender skin of the child.

In use, the diaper 11 is arranged as in Figure 6 around the body of the wearer. In such a position, the portion of the central section 35 intermediate the pleats 29 extends between the legs of the child and upwardly both forwardly and rearwardly to cover the lower abdomen and buttocks respectively. This portion of the diaper is thus positioned so as to receive the initial flood of body fluids from the child. However, since it is uncompressed and of greater thickness, it has the highest absorptive capacity of any portion of the diaper and is thus most capable of retaining the fluids.

Some fluid will flow from the area intermediate the pleats to the pleats as the intermediate area becomes saturated. This flow is received principally by the margins 35a of the thicker central portion 35 of the pad, which margins underlie the pleat folds 29a and 29b. Since these margins 35a are of greater thickness than the pleat folds, they have a greater absorptive capacity and, hence, a greater resistance to strike through than the folds 29a and 29b. They are thus more capable of receiving overflow than the folds. Furthermore,

5 since all portions of the pleats are in a partially compressed state, they all provide some wicking action and there is therefore a tendency for the fluid to be drawn upwardly through the pleats for dispersion throughout the upper portions of the uncompressed pad, as well as throughout the pleats themselves, thereby further minimizing the likelihood of strike through at the pleats.

10 Those portions of the pleats 29 midway between the embossed end portions 25 of the diaper encircle the legs of the child, serving as a seal which retards the flow of body fluids outwardly along the legs. In this regard, it will be noted that the unpegged inner fold 29b of each pleat expands into contact with the leg of the child (Fig. 7), thereby enhancing the sealing ability of the pleats.

20 The portions of the pleats adjacent the ends of the diaper are unfolded to permit the embossed end portions 25 to fully encircle the waist of the wearer and to provide a location for safety pins or other fasteners. In this regard, a suggested arrangement is to position the opposite ends of the folds 29 back to back to receive a safety pin, as shown in Figure 6.

30 That portion of the diaper which is uppermost and encircles the waist of the child when the diaper is worn contains the embossing 25 and also the cross strips or belly bands 21. Both serve to strengthen the upper end of the diaper at the waist, and at the areas where safety pins are received. The belly bands 21, being stretchable along the width of the diaper, permit a snug fit around the waist while allowing sufficient give to insure the child's comfort.

40 Figure 8 illustrates another embodiment of the invention showing a diaper 11a identical to the diaper 11 but provided in addition with a sheet 41 which is approximately the width of the pad 15 and which is disposed intermediate the webs 13 and 19 and held in place by the transverse embossing at the ends of the diaper. The sheet 41 is preferably formed of a material such as crepe tissue paper impregnated with about ten to fifteen percent (10—15%) by weight of micro-crystalline wax. The sheet will thus retard the flow of fluid through the diaper from its inner to its outer

face until sufficient time has elapsed for the fluid to be adequately dispersed. Thus, the flow of fluid through the diaper is controlled and a rapid flow completely through the diaper is prevented. However, the sheet is preferably not fluid impervious, thereby permitting the passage of air, allowing adequate ventilation, and serving in some degree to prevent diaper rash.

#### WHAT WE CLAIM IS:—

60 1. An assembly of material for forming disposable diapers comprising a pad of loose fibers of cellulosic material formed as a single layer, and an envelope enclosing said pad, said enclosed pad having side edge portions folded inwardly and then back upon themselves so that on each side there is formed a leg-engaging pleat, said pleat having an inner and outer fold, the folds of the pleats being permanently compressed by calendering and thereby being held down, and the portion of the pad intermediate said pleats being relatively uncompressed.

75 2. A method of assembling material to form disposable diapers comprising the steps of continuously moving a permeable carrier web having a predetermined width along a given path, continuously laying on said carrier a pad of loose fibers of cellulosic material as a single integral layer with the pad extending longitudinally of the carrier, forming an envelope around the pad to enclose the pad by folding the carrier web, folding each side edge portion of the enclosed pad inwardly and then back upon itself to form a leg-engaging pleat, having an inner and outer fold, along each side of the unpleated central portion of the pad, and subjecting the enclosed folded pad to calendering pressure normal to the plane thereof so as to impart a permanent compression to hold down the outer fold tightly against the inner fold without imparting any significant permanent compression to the portion of said pad intermediate said pleats.

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